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Datura stramonium (Solanaceae): Antioxidant and Antimicrobial Potentials

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ABSTRACT

Many people in different parts of the world benefit from alternative medicine in the treatment and prevention of diseases. Plants are among the important natural materials used in alternative medicine. In this study, the antioxidant and antimicrobial potential of *Datura stramonium* L. was determined. Ethanol extracts of the plant's flower parts were obtained in the soxhlet device. The antioxidant and oxidant potential of the plant extract was determined using Rel Assay TAS and TOS kits. Antimicrobial activity was tested by the agar dilution method. The TAS value of the plant extract was 7.559±0.224 mmol/L, the TOS value was 10.711±0.243 µmol/L, and the OSI value was 0.142±0.002. It was determined that the plant extract was effective against bacteria and fungus strains at 100-400 µg/mL concentration. As a result, it was determined in our study that *D. stramonium* can be a natural antioxidant and antimicrobial source.

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Introduction

From past to present, many communities have benefited from alternative medicine in the treatment and prevention of diseases. Many different natural materials such as plants, mushrooms and animals are used in alternative medicine (Krupodorova and Sevindik, 2020; Salehi et al., 2020a). Especially plants contain the active ingredients of many drugs used against different diseases. Many studies have shown that plants have different biological activities. In these studies, it has been reported that herbs have different effects such as antioxidant, anticancer, antitumor, DNA protective, antiproliferative, anti-inflammatory, antimicrobial and antiallergic (Calixto et al., 2001; Schinella et al., 2002; Miliauskaset al., 2004; Makchuchit et al., 2017; Lichota and Gwozdzinski, 2018; Khanet al., 2019; Salehi et al., 2019; Salehi et al., 2020b). In this study, the antioxidant and antimicrobial activity of *Datura stramonium* L. was determined.

D. stramonium from the Solanaceae family is known as prickly apple, jimsonweed or devil's snare. Although it originates in Central America, it is distributed in different parts of the world. It is very common, especially in temperate climates. It spreads naturally in hot and temperate regions of the world, along roadsides and in manure-rich animal shelters. It is found as a weed in dumpsites and wasteland in Europe (Lovett et al., 1981). And it can be toxic to animals that consume it. The seeds of the plant can remain passive underground for many years and can sprout when the soil deteriorates. *D. stramonium* is frequently used in alternative medicine for the treatment of many different ailments. It is used in alternative medicine, especially due to its analgesic and anesthetic properties. It is also used in the treatment of epilepsy and asthma (Lewis, 1784; Culpeper, 1995; Pennacchio et al., 2010). However, the plant has been reported to have halcinogenic properties. It causes many mental and physical effects. It can also cause a profound and prolonged disorientation with potentially fatal consequences. It contains tropane alkaloids, which cause these effects and can be highly toxic. *Datura* species contain tropane alkaloids such as atropine, hyoscyamine and scopolamine, which are called delirants or anticholinergics, in all plant parts. The risk of overdose by uninformed consumers is quite high, and hospitalization for recreational users is quite high due to its psychoactive properties (Barceloux, 2008; Glatstein et al., 2016).

Materials and Methods

D. stramonium samples were collected from Turkey (Gaziantep/Şahinbey). Flora of Turkey and the East Aegean Islands, Volume 6 was used in the identification of the plant (Davis, 1965). Flower parts of the plant were dried in a breathable environment. 30 g of the dry samples were weighed and pulverized in a mechanical shredder. Powder samples were extracted at 50 ^{0}C with 200 mL of EtOH during approximately 6 hours (Gerhardt EV 14). The solvent was removed in the concentrator after Soxhlet apparatus (Heidolph Laborota 4000 Rotary Evaporator).

Antimicrobial Activity Studies

The effects of the EtOH extract of the flower parts of the plant against microorganisms were determined using the agar dilution method. The concentrations of the extracts were adjusted in the range of 6.25-800 µg/mL. Extract concentrations were adjusted with distilled water. The lowest concentrations of the extracts preventing the growth of bacteria and fungi were determined in the study (CLSI, 2012; EUCAST, 2014; EUCAST, 2015). Test bacteria were used as *Pseudomonas aeruginosa* ATCC 27853, *Acinetobacter baumannii* ATCC 19606, *Staphylococcus aureus* ATCC 29213, *S. aureus* MRSA ATCC 43300, *Enterococcus faecalis* ATCC 29212 and *Escherichia coli* ATCC 25922. Test fungi *Candida albicans* ATCC 10231, *C. krusei* ATCC 34135 and *C. glabrata* ATCC 90030 were used. Bacteria pre-culturing was done in Muller Hinton Broth medium and Amikacin, Ampicillin and Ciprofloxacin were used as reference drugs. The pre-culturing of the fungi was done in RPMI 1640 Broth medium and Fluconazole and Amphotericin B were used as reference drugs (Bauer et al., 1966; Hindler et al., 1992; Matuschek et al., 2014).

Antioxidant Tests

The antioxidant status of the plant extract was measured using the Rel Assay TAS kit and Trolox was used as the calibrator (Erel, 2004). In addition, oxidant status was determined using the TOS kit and hydrogen peroxide was used as a calibrator (Erel, 2005). The oxidative stress index (OSI, µmol H_2O_2 equiv./L) was found by equalizing the unit of the TOS value and the unit of the TAS (mmol Trolox equiv./L) value. The following formula was used to determine the OSI value (Sevindik, 2019).

$$\text{OSI (AU)} = \text{TOS}/(\text{OSI} \times 10) \times 10$$

Results and Discussion

Antimicrobial potential

In recent years, the discovery of new antibiotics has been inevitable due to the resistance of microorganisms to antibiotics. In addition, due to the possible side effects of synthetic antibiotics, interest in natural antimicrobial products is increasing (Zazharskyi et al., 2019; Sevindik, 2020). In this study, the effect of the EtOH extract of *D. stramonium* against test bacteria and fungi was investigated. The results obtained are shown in Table 1.

Table 1. Antibacterial and antifungal activities of *D. stramonium*

Microorganisms	EtOH
S. aureus	100
S. aureus MRSA	100
E. faecalis	200
E. coli	100
P. aeruginosa	100
A. baumannii	400
C. albicans	200
C. glabrata	200
C. krusei	200

*The MIC values are presented in units of µg/mL.

It was previously reported that the methanol extract of *D. stramonium* is effective against *Bacillus thuringiensis, B. subtilis Pseudomonas aeruginosa, Agrobacterium tumefaciens, Escherichia coli, Enterococous faecalis, Staphylococcus aureus* and *Klebsiella pneumoniae* (Eftekhar et al., 2005; Deshmukh et al., 2015). In addition, benzene, chloroform and ethanol extracts of *D. stramonium* were reported to be effective against *Enterobacter, Klebsiella pneumoniae, Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa* and *Micrococcus luteus* (Gul et al., 2012). Ethanol, methanol, acetone and chloroform extracts of *D. stramonium* have been reported to be effective against Escherichia coli, Staphylococcus aureus, Streptococcus pneumoniae and their clinical isolates (Baynesagne et al., 2017). In our study, it was determined that the ethanol extract of *D. stramonium* was effective against A. baumannii at 400 µg/mL concentration. In addition, it was determined that the plant extract was effective against *E. faecalis, C. albicans, C. glabrata* and *C. krusei* at 200 µg/mL concentration. In addition, it was determined that it was effective against *S. aureus, S. aureus MRSA, E. coli* and *P. aeruginosa* at 100 µg/mL concentration. As a result, in our study, it was seen that *D. stramonium* has antimicrobial activity against test bacteria and fungi. In this context, it was determined that the flower parts of the plant could be a natural antimicrobial agent.

Antioxidant and Oxidant Status

Plant based antioxidants are widely used to prevent oxidative degradation. Oxidative degradation occurs in living organisms with the accumulation and increase of levels of oxidant compounds produced as a result of metabolic activities (Adebiyi et al., 2017). In such cases, the antioxidant defense system can prevent or suppress oxidative damage in the living organism. In cases where endogenous antioxidants are insufficient, supplemental antioxidants can be used (Arnao et al., 1999; Xiang et al., 2019). In our study, the utilization potential of *D. stramonium* as a natural antioxidant agent was determined. The findings obtained are shown in Table 2.

Table 1. Antioxidant and oxidant status of *D. stramonium*

Parameters	*D. stramonium*
TAS	7.559±0.224
TOS	10.711±0.243
OSI	0.142±0.002

Values are presented as mean±SD

In previous studies, it was reported that petroleum ether, benzene, solvent ether, chloroform, acetone, ethanol and methanol extracts of *D. stramonium* had antioxidant potential with different methods (DPPH radical scavenging assay, Superoxide radical scavenging assay, ABTS + radical cation scavenging assay, Hydroxyl (OH) radical scavenging assay, Nitric oxide (NO) radical scavenging assay, Ferric (Fe3 +) reducing power assay, Phosphomolybdenum reduction assay) (Kumar et al., 2008; Sreenivasa et al., 2012; Iqbal et al. , 2017; Belayneh et al., 2019). In our study, the antioxidant potential of EtoH extract of D. stramonium was determined for the first time using TAS and TOS kits. In TAS and TOS studies previously performed on different plant species, TAS values of *Mentha longifolia* subsp. *longifolia*, *Allium calocephalum*, *Ferulago platycarpa*, *Gundellia tournefortii*, *Rhus coriaria* var. *zebaria*, *Rumex crispus* and *Scorzonera papposa* were reported as 3.628, 5.853, 5.688, 6.831, 7.342, 6.758 and 5.314 mmol/L, respectively. The TOS values were reported as 4.046, 16.288, 15.552, 3.712, 5.170, 5.802 and 24.199. OSI values were reported as 0.112, 0.278, 0.273, 0.054, 0.071, 0.086 and 0.473 (Sevindik et al., 2017; Mohammed et al., 2018; Daştan et al., 2019; Mohammed et al., 2019; Saraç et al., 2019; Mohammed et al., 2020a; Mohammed et al., 2020b). Compared to these studies, it was determined that the TAS value of *D. stramonium* was higher than *M. longifolia* subsp. *longifolia*, *A. calocephalum*, *F. platycarpa*, *G. tournefortii*, *R. coriaria* var. *zebaria*, *R. crispus* and *S. papposa*. TAS value shows the whole of the antioxidant active compounds in the plant. In this context, it has been observed that the antioxidant potential of *D. stramonium* is high. As a result, it was determined that the plant has significant antioxidant activity.

It was also determined that the TOS value of *D. stramonium* was higher than *M. longifolia* subsp. *longifolia*, *G. tournefortii*, *R. coriaria* var. *zebaria* and *R. crispus* and lower than *A. calocephalum*, *F. platycarpa* and *S. papposa*. The TOS value indicates the whole of oxidant-featured compounds produced in the plant by environmental effects. In this context, it was determined that the TOS value of the plant was at normal levels. In addition, when the OSI value showing the suppression of oxidant compounds by endogenous antioxidants is examined, it was determined that *D. stramonium* had higher values than *M. longifolia* subsp. *longifolia*, *G. tournefortii*, *R. coriaria* var. *zebaria* and *R. crispus* and lower than *A. calocephalum*, *F. platycarpa* and *S. papposa*. In this context, it was seen that the endogenous antioxidant potential of the plant suppressed endogenous oxidant compounds well. As a result, it was determined that the plant could be a natural source of antioxidants.

Conclusion

In this study, the antioxidant and oxidant status and antimicrobial activity of *D. stramonium* were determined. It was determined that the plant's antioxidant potential was high. In addition, oxidant levels were found to be at normal levels. In addition, it was found to be effective against bacteria and fungus strains. As a result, it was determined that the plant has antioxidant and antimicrobial potentials.

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